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Science and Art Gossip.

AT the request of several of our readers, who consider that these notes on Science and Art should be made a more prominent feature, we propose in future to give "Science and Art Gossip" the foremost place in our pages. We shall be glad to receive from contributors, correspondents, and subscribers generally, notes on matters of interest, suitable for these columns, briefly (as well as plainly) worded, and as exactly as possible described. We apprehend from past experience that a selection will have to be made; but trust none who may send notes will be annoyed if want of space should prevent insertion.

THE Trustees of the Gilchrist Educational Trust have arranged for courses of "Science Lectures for the People," during the ensuing winter, in five towns of central Lancashire, in five Scotch towns, and in Leicester, Lincoln, Chesterfield, Doncaster, York, Reading, and Banbury. The lecturers who will take part in them are Dr. Carpenter, F.R.S. (the Secretary to the Trust), Professor Balfour Stewart, F.R.S., Professor W. C. Williamson, F.R.S., Dr. Martin Duncan, F.R.S., Rev. W. H. Dallinger, F.R.S., Mr. W. Lant Carpenter, B.Sc., F.C.S., Dr. Andrew Wilson, F.R.S.E., and Mr. R. A. Proctor.

THE report on the proposed grant to the French Minister of Posts and Telegraphs of a sum of £3,600, in view of the meeting of electricians, has been sent to the French Senate, after having been adopted by the Chamber of Deputies. This meeting will take place in October. One of the reasons alleged for the delay is the necessity of installing the magnetic instruments now in course of construction for the observatory of Paris. The assent of the French Senate is stated to be beyond a doubt.

CARRIER PIGEONS FOR NAVAL SERVICE.—The Secretary of the German Navy has resolved to employ carrier pigeons in the coasting service, all the experiments with them made by the Prussian Government on the coast of the North Sea, since 1876, to establish communication with the lightships lying off the coast having been successful.

THE SYLLABLE "-ING" IN PLACE-NAMES.—Two of the most important military roads are known as "Emming" Street and "Watling" Street, names which they no doubt bore not only during the Roman occupation, but probably before. The word "street" appears to be surplusage, and "Watling" a corruption of Keltic *gaoidileach-eang* (*i.e.*, *eanach*), signifying the Gaelic or Irish road, running from south-east to north-west, as illustrated by applying the name Watling-street to the Milky Way, which has a course nearly parallel to it. [This is a rather startling statement. The course of the Milky Way changes from hour to hour, with reference to the compass-points.—ED.] "Erming" may be from the Keltic *eirim-eang*, a riding road, one for the use of horses; and, possibly, it is the most ancient of our commercial roads, opening a communication between the Phenician traders and the inland parts. The forms "Watlinga" and "Erminga" are, probably, survivals from the Roman names "Watlinga via" and "Erminga via."—Mr. Walford's *Antiquarian Magazine*.

THE ROYAL AQUARIUM WINTER ELECTRIC EXHIBITION.—We hear with great pleasure that the managers of the Royal Aquarium, Westminster, taking advantage of the conveniently central and accessible position of the Aquarium, have made arrangements to hold an exhibition, illustrating the latest applications of electricity to public and domestic requirements. It is intended that the exhibits shall, as far as possible, be subjected to practical and useful tests, with the view of ascertaining the actual and relative values of the various systems and apparatus shown. Thus a preliminary programme has been arranged for testing the different kinds of incandescence lamps, for the best system of which a prize of one hundred guineas will be offered. It is proposed that each exhibitor entering this competition should be allotted a chandelier of 100 lights, the details of arrangement being left to the respective exhibitors, while the directors of the exhibition will retain the entire control of the various chandeliers. A record of all renewals rendered necessary will be made, the different causes of such renewals being noted; from time to time, photometric measurements will be taken, and the power absorbed in producing the light will be accurately ascertained. The duration of lighting during the proposed term of the exhibition will be about 800 hours, and, as it is intended to make the necessary tests frequently, a very accurate estimate of the relative values of different systems will be obtained. In a similar way, information will be gained in reference to storage batteries, and a prize of one hundred guineas will be offered for the best system, including batteries, adapted for a central depôt, and small portable wires to feed six incandescence lamps. In all, £1,000 will be distributed in prizes, under the direction of a carefully-selected scientific jury. We wish the enterprise the success which it well deserves.

FASTING IN ACUTE RHEUMATISM.—Dr. Wood, Professor of Chemistry in the Medical Department of Bishop's College, Montreal, reports in the *Canada Medical Record* a number of cases in which acute articular rheumatism was cured by fasting, usually from four to eight days. In no case was it necessary to fast more than ten days. Less positive results were obtained in cases of chronic rheumatism. The patients were allowed to drink freely of cold water, or lemonade in moderate quantities if they preferred. No medicines were given. Dr. Wood says that from the quick and almost invariably good results obtained by simple

abstinence from food in more than forty cases in his own practice, he is inclined to believe that rheumatism is, after all, only a phase of indigestion, to be cured by giving complete and continued rest to all the viscera.

Scientific Observatories at the North Pole.—In a recent paper, describing the observatories that are about to be established in the Polar regions by the German and other Governments, Professor Neumayer said that the Cumberland Strait Station is notable for its position near the magnetic North Pole, it being also not very far from the centre of the magnetic forces of the earth. The difficulties of this situation, consisting in the disturbances produced by the magnetic currents, are obviated by peculiarities in the construction of the instruments to be employed there. He also stated that a conference of the directors of meteorological stations is to be held at Copenhagen to consider the desirability of laying a telegraph cable from Canada through the region traversed by the great storms of the American continent, so as to make it possible to foretell the future weather for five or six days, whereas, at present, the weather predictions of the *New York Herald* are of little practical value.

Converting a Negative into a Positive.—Captain Bing, of Paris, has devised an ingenious method of making a positive on glass from a negative, and on the same glass. The back of the negative is covered with soluble bitumen or asphalt and then illuminated through the negative. After an exposure sufficient to render the light portion insoluble, the remainder of the asphalt is dissolved off with any of the usual solvents, leaving a positive. The silver negative is then dissolved off with the chloride of copper and a fixing agent, such as cyanide or hypo.—*Scientific American.*

To Keep Silver-plated Articles Bright.—Frank L. James, Ph.D., M.D., Prof. Chem. and Tox., St. Louis Coll. of Phys. and Surgeons, writes to the *Scientific American*:—Articles of silver and silver-plated ware rapidly tarnish when kept in rooms where gas is used for illuminating purposes, and everywhere in cities like St. Louis, Pittsburg, Cincinnati, &c., where the air is constantly filled with sulphurous vapours. My cabinet of silver-plated specimens, instruments, and water pitchers used to give no end of trouble this way. This is all avoided now by dipping the articles occasionally in a solution of hypo-sulphite of soda. Large articles, like pitchers and salvers, should be wiped off with a rag dipped in the solution, and dried with a soft towel. A rub with a bit of chamois leather makes them as brilliant as new.

The American Association.—The American Association for the Advancement of Science will meet at Buffalo, N.Y., August 23.—*Scientific American.*

"L'Electricité," in an article on the progress of electrical science, remarks that in all the most striking of recent advances it is improvement rather than invention that comes to the front, and that no compromise or equivocation can deny justice to the real original discoverers. "Bell does not efface Reis, in spite of the recent Chancery suit; Faure cannot destroy Planté; and Swan, Edison, and the others cannot suppress the anterior labours of Changy."

WAS RAMESES II. THE PHARAOH OF THE OPPRESSION?

By Amelia B. Edwards.

VI.—THE HYKSHOS CALENDAR AND THE EXODUS ACCORDING TO THE CONSECUTIVE THEORY.

HAVING seen how closely the relative dates of the Tanis Tablets, the accession of Ahmes, the expulsion of the Hykshos, and the entry and Exodus of the Hebrews can be brought into correspondence with the synchronous theory, which merges thirty years of the reign of Rameses II. in the reign of Seti I., we will next examine how far the relative dates of these same events are compatible with the consecutive theory, which counts the first regnal year of Rameses II., from the decease of Seti I., B.C. 1405. For this purpose (it being obviously unnecessary to go step by step over the ground a second time) a chronological table of the two schemes of reckoning will answer every purpose, and enable us to compare the plausibility of both hypotheses. It must be noted, however, that certain of our dates have to be regarded as compulsory. Whether we do, or do not, admit the thirty synchronous years of Seti and Rameses, the XVIIIth and XIXth dynasties must always begin, according to Mariette, in B.C. 1703 and B.C. 1462; the Tablet of Sān must always count 400 years from some point in the reign of Nubti to some point in the reign of Rameses II.; and the Exodus must always take place 430 years after the entry of Jacob and his household into the land of Egypt.

APPROXIMATE CHRONOLOGY OF THE EXODUS.

Synchronous. B.C.		Consecutive. B.C.
1836	Birth of Joseph	1806
1806	Joseph raised to power	
1800	Era of Nubti	**1800**
	Joseph raised to power	1776
1799	Seventh year of plenty	1769
1797	Second year of famine	1767
1796	Entry of Jacob into Egypt	1766
?	Accession of Apapi (last Hykshos king)	?
1727	Commencement of the National War	**1727**
1726	Death of Joseph	
1703	Accession of Ahmes I., and commencement of XVIIIth Dynasty	**1703**
1697	Expulsion of the Hykshos	**1697**
	Death of Joseph	1696
1462	Beginning of XIXth Dynasty, and accession of Rameses I.	**1462**
1456	Accession of Seti I.	**1456**
1435	Co-royalty of Rameses II.	1435
(As co-Pharaoh)		(As Prince-regent only.)
1405	Death of Seti I., and accession (in full) of Rameses II.	**1405**
1400	Fourth centenary of Nubti	**1400**
1368	Death of Rameses II., and accession of Menephthah	1338
1366	Exodus of the Hebrews	1336

The above table, it must be understood, is drawn up simply to show that, *whether computed synchronously or consecutively*, the great events of these important 500 years of the world's history might quite possibly have happened in strict accordance with the relative spaces of time recorded upon the Egyptian monuments, and in the early books of the Bible. The difference between the two methods of computation is a difference which affects Joseph's place in history, and leaves a margin of thirty years for the date of the death of Rameses II. According

to the one hypothesis, Joseph interprets Nubti's dream six years before the establishment of the Hykshos Calendar; according to the other, he interprets the dream twenty-four years after the establishment of the Calendar. By the first reckoning, the reign of Nubti does not necessarily cover a space of more than fifteen years; by the last, Nubti must be credited with a reign of certainly not less than thirty-eight years, there being just thirty-eight years between the institution of the calendar and the end of the famine. The Bible, indeed, implies that the same Pharaoh who had raised Joseph to power was yet upon the throne when Jacob died seventeen years later; and that it was he who sent his elders and servants, and a great company of horsemen and chariots, to escort the mummy of his Prime Minister's father with all honour to his place of burial in the cave of Machpelah, in the land of Canaan, beyond Jordan; a sepulchre, by the way, which has never been violated, and in which—held sacred alike by Jew and Moslem—the remains of Jacob undoubtedly repose to this day. Again, the one scheme supposes Joseph to have seen only the commencement of the war of liberation, and to have died during the reign of Apapi; whereas the other scheme causes him to outlive the whole struggle, to witness the downfall of Apapi, and to die in the seventh year of Ahmes, just one year after the expulsion of the last remnants of the Hykshos. Lastly, the synchronous theory brings the Fourth Centenary of the Era of Nubti into the thirty-fifth regnal year of Rameses II. (B.C. 1400); while the consecutive theory, adhering to the same date for that event, brings it into the fifth regnal year of Rameses II. The two schemes are, therefore, equally possible, and perhaps equally probable, though neither is proven. I give them merely for what they are worth. Of the actual date at which these events happened we know nothing. The particular years which I have assigned to them, first synchronously and then consecutively, are advanced neither theoretically nor controversially; nor in any sense save that of expediency. I repeat that they are assigned only with reference to each other, and not as definite dates in relation to the period in which we live. The whole scheme—or rather the twofold scheme—might be shifted two or three centuries up or down the scale of ages without affecting its probability or its coherence.

I may here observe that nothing shows the loose and uncertain state of Egyptian chronology more strikingly than the curious diversity of opinion which exists among the learned in regard to the date of the accession of Rameses II.; a king of whom it may be said that the events of his reign are as well known to us, and as well authenticated, as the events of the reigns of Trajan or Titus. The following table (which does not represent all the opinions that might be quoted) differs by 72 years in the highest and lowest estimates:—

		B.C.
Rameses II. began to reign, according to	Mariette	1405
	Lepsius	1388
	Wilkinson	1355
	Bunsen	1352
	Brugsch	1333

LEATHEROID.—Leatheroid is a new article made of paper. It consists of a number of thicknesses of cotton paper wound one upon another over a cylinder. The remarkable qualities of strength and adhesion it possesses are derived from a chemical bath, through which the paper is drawn on its way to the cylinder. It is moulded wet, and retains its form. When dry, it cuts like raw hide.

MATTHEW ARNOLD ON KNOWLEDGE.*

WHEN we talk of knowing Greek and Roman antiquity, which is what people have called humanism, we mean a knowledge which is something more than a superficial humanism, mainly decorative. "I call all teaching *scientific*," says Wolf, the critic of Homer, "which is systematically laid out and followed up to its original sources. For example, a knowledge of classical antiquity is scientific when the remains of classical antiquity are correctly studied in the original languages." There can be no doubt that Wolf is perfectly right, that all learning is scientific which is systematically laid out and followed up to its original sources, and that a genuine humanism is scientific.

When I speak of knowing Greek and Roman antiquity, therefore, as a help to knowing ourselves and the world, I mean more than a knowledge of so much vocabulary, so much grammar, so many portions of authors, in the Greek and Latin languages. I mean knowing the Greeks and Romans, and their life and genius, and what they were and did in the world; what we get from them, and what is its value. That, at least, is the ideal; and when we talk of endeavouring to know Greek and Roman antiquity as a help to our knowing ourselves and the world, we mean endeavouring so to know them as to satisfy this ideal, however much we may still fall short of it.

The same as to knowing our own and other modern nations, with the aim of getting to understand ourselves and the world. To know the best that has been thought and said by the modern nations, is to know, says Professor Huxley, "only what modern *literatures* have to tell us; it is the criticism of life contained in modern literature." And yet "the distinctive character of our times," he urges, "lies in the vast and constantly-increasing part which is played by natural knowledge." And how, therefore, can a man, devoid of knowledge of what physical science has done in the last century, enter hopefully upon a criticism of modern life?

Knowing the best which modern nations have thought and said is not knowing their *belles lettres* merely. To know Italian *belles lettres* is not to know Italy, and to know English *belles lettres* is not to know England. Into knowing Italy and England there comes a great deal more, Galileo and Newton amongst it. The reproach of being a superficial humanism, a tincture of *belles lettres*, may attach rightly enough to some other disciplines; but to the particular discipline recommended when I proposed knowing the best that has been thought and said in the world, it does not apply. In that best I certainly include what in modern times has been thought and said by the great observers and knowers of nature.

The great results of the scientific investigation of nature we are agreed upon knowing, but how much of our study are we bound to give to the processes by which those results are reached? The results have their visible bearing on human life. But all the processes, too, all the items of fact, by which these results are established, are interesting. All knowledge is interesting to a wise man, and the knowledge of nature is interesting to all men. It is very interesting to know that from the albuminous white of the egg the chick in the egg gets the materials for its flesh, bones, blood, and feathers, while from the fatty yolk of the egg it gets the heat and energy which enable it at length to break its shell and begin the world. It is less interesting, perhaps, but still it is interesting, to

* From an article on "Literature and Science," in the *Nineteenth Century* for the present month.

know that when a taper burns, the wax is converted into carbonic acid and water. But as we go on learning and knowing, the vast majority of mankind feel the need of relating what we have learnt and known to the sense which we have in us for conduct, to the sense which we have in us for beauty.

Knowledges which cannot be directly related to the sense for beauty, to the sense for conduct, are instrument-knowledges; they lead on to other knowledge, which can. A man who passes his life in instrument-knowledges is a specialist. They may be invaluable as instruments to something beyond, for those who have the gift thus to employ them; and they may be disciplines in themselves wherein it is useful to every one to have some schooling. But it is inconceivable that the generality of men should pass all their mental life with Greek accents or with formal logic. My friend Professor Sylvester, who holds transcendental doctrines as to the virtue of mathematics, is far away in America; and therefore, if in the Cambridge Senate House one may say such a thing without profaneness, I will hazard the opinion that for the majority of mankind a little of mathematics, also, goes a long way. Of course, this is quite consistent with their being of immense importance as an instrument to something else; but it is the few who have the aptitude for thus using them, not the bulk of mankind.

The natural sciences do not stand on the same footing with these instrument-knowledges. Experience shows us that the generality of men will find more interest in learning that when a taper burns, the wax is converted into carbonic acid and water, or in learning the explanation of the phenomenon of dew, or in learning how the circulation of the blood is carried on, than they find in learning that the genitive plural of *pais* and *pas* does not take the circumflex on the termination. And one piece of natural knowledge is added to another, and others to that, and at last we come to propositions so interesting as the proposition that "our ancestor was a hairy quadruped, furnished with a tail and pointed ears, probably arboreal in his habits." Or we come to propositions of such reach and importance as those which Professor Huxley brings us, when he says that the notions of our forefathers about the beginning and the end of the world were all wrong, and that nature is the expression of a definite order with which nothing interferes.

Interesting, indeed, these results of science are, important they are, and we should all be acquainted with them. But what I now wish you to mark is, that we are still, when they are propounded to us and we receive them, we are still in the sphere of intellect and knowledge. And for the generality of men there will be found, I say, to arise, when they have duly taken in the proposition that their ancestor was "a hairy quadruped, furnished with a tail and pointed ears, probably arboreal in his habits," there will be found to arise an invincible desire to relate this proposition to the sense within them for conduct and to the sense for beauty. But this the men of science will not do for us, and will hardly, even, profess to do. They will give us other pieces of knowledge, other facts, about other animals and their ancestors, or about plants, or about stones, or about stars; and they may finally bring us to those "general conceptions of the universe which have been forced upon us," says Professor Huxley, "by physical science." But still it will be knowledge only which they give us; knowledge not put for us into relation with our sense for conduct, our sense for beauty, and touched with emotion by being so put; not thus put for us, and therefore, to the majority of mankind, after a certain while unsatisfying, wearying.

If there is to be separation and option between humane letters on the one hand, and the natural sciences on the other, the great majority of mankind, all who have not exceptional and overpowering aptitudes for the study of nature, would do well, I cannot but think, to choose to be educated in humane letters rather than in the natural sciences. Letters will call out their being at more points, will make them live more. And letters will not in the end lose their leading place. If they lose it for a time, they will get it back again. We shall be brought back to them by our wants and aspirations. And a poor humanist may possess his soul in patience, neither strive nor cry, admit the energy and brilliancy of the partisans of physical science, and their present favour with the public, to be far greater than his own, and still have a happy faith that the nature of things works silently on behalf of the studies which he loves, and that, while we shall all have to acquaint ourselves with the great results reached by modern science, and to give ourselves as much training in its disciplines as we can conveniently carry, yet the majority of men will always require humane letters, and so much the more as they have the more and the greater results of science to relate to the need in man for conduct, and to the need in him for beauty.

FUTURE SOURCES OF OUR FOOD SUPPLY.

By Percy Russell.

III.—AUSTRALASIA (*Continued*).

QUEENSLAND is, to a great extent, a subtropical region, and the strength of the leading agriculturists of the colony is concentrated on the production of sugar and coffee, rice, &c., and the like. Still, much good wheat is raised, and there are extensive areas—elevated plateaux—where wheat can be grown to great advantage, as it is in the Punjaub. The area of the colony is 669,520 square miles, but in 1880 only 112,290 acres were under crop. The live stock included 179,152 horses, 3,162,752 head of cattle, and nearly 7,000,000 of sheep. The population was 226,000.

Tasmania embraces an area of 26,215 square miles, of which 140,788 acres were under crop, showing a higher relative rate of agricultural progress than Queensland. The population was at the period under review 114,762, and the live stock return was as follows:—25,267 horses, 127,187 horned cattle, and 1,783,000 sheep. It is generally agreed that Tasmania in many respects bears a very close resemblance to England; and this resemblance is, in respect to its flora, very complete. I mean, of course, the flora artificially introduced by the processes of settlements. The abundance of fruit of all kinds produced is enormously in excess of home wants, and vast quantities are exported to the neighbouring colonies, and might be exported with special advantage to England, if the necessary mercantile machinery could be properly organised.

Passing from the continent to New Zealand, that Britain of the south, as it has been happily called, we find that the total area is 67,419,107 acres, of which only 917,701 acres are under crop, 324,933 being devoted to wheat. The live stock returns include 137,768 horses, 578,430 horned cattle, 13,069,338 sheep, over 200,000 pigs, and more than a million of poultry. The total population on April 3, 1881, was 489,909; it therefore follows that in round numbers, to every individual man, woman, child, or infant, there are in the colony more than twenty-five

sheep! As to vegetable products, the soil of New Zealand is specially well suited to all fruits or vegetables raised in Great Britain, while the indigenous grasses in the interior are of a fine quality for feeding purposes, and sustain in excellent condition the millions of sheep which constitute much of the real wealth of these nature-favoured regions. The famous Canterbury plains are well known for the excellent quality and high yield per acre of the wheats there grown; while all around the tortuous coast-line, reckoned at full 3,000 miles, there abounds fish of fine quality, fit for table, and in numbers practically unlimited. Thus we may particularise the hapuka, a large, cod-like fish, king-fish, sole, dory, flounder, and very many others, to say nothing of oysters and various crustacea. In fact, the harvest of the sea would undoubtedly make a conspicuous figure in the food resources of these islands, were it not that the harvests of the land are so extravagantly ample as to render fish of quite secondary account—like the fine honey of the West Australians, it is too common to be of much commercial account.

We have now rapidly sketched the food-raising capacity of the Australasian colonies in a rough and superficial manner, but sufficiently to demonstrate that there, indeed, production is not only in the ascendant, but must remain so for many years to come, and, meanwhile, has for its only check such mechanical difficulties as still prevent us benefiting in our home food markets by the unlimited superabundance of all the principal food-stuffs—to use an expressive if uncouth phrase—that our antipodean friends now find emphatically a burden on their hands. To emphasise the existing state of things let us now take the aggregate estimate furnished by the best official sources of production in the Austral world in relation to population and territory. First, then, the total area of these bounteous regions amounts to 3,103,903 square miles, with an aggregate population of 1,499,258 males. The land under actual cultivation was at the period in question 6,371,238 acres, and the agricultural produce amounted to 36,346,950 bushels of wheat, 17,766,875 bushels of oats, 3,506,191 of barley, and 6,335,239 of maize. In addition to all this, there were produced 424,155 tons of potatoes, nearly 1,000,000 tons of hay, and 1,871,861 gallons of wine. As to the flocks and herds belonging to this singularly favoured community, just a million and a half strong, or, including females, 2,715,792 all told, we find the horses were 1,064,655; cattle, 7,878,782; sheep, 65,915,765; pigs, 822,337; making a grand total of 75,681,539. A further analysis of these astounding returns brings out the remarkable and suggestive fact, that while, taking the total population at 2,715,792, there were only ·875 persons to the square mile, the flocks and herds stood at 24·38! The revenue raised by these peculiarly favoured colonists for the year 1879 amounted to £15,927,488, and in 1880 had increased to £17,069,016, while the value of the imports amounted to £45,060,666, and that of the exports to £48,866,168! In other words, the value of the trade per head of the inhabitants, infants included, was then about £35 per annum. It is melancholy to contrast such a state of things with that prevailing among ourselves at home. Australasia probably gives an example of universally diffused real wealth, not only unknown in any other country of the world, but historically unparalleled. It must be remembered, too, that this extraordinary development of production has come about naturally without any special concerted efforts on the part of the colonists to show to the world what *could* be done in regions where the mass of the people were really enfranchised and the true lords of the soil. It is easy to imagine how much even this enormous productiveness of the Austral colonies would be directly stimulated if national systematic efforts were made here to organise proper markets for the reception of their surplus food-products, and if special lines of steamers were established to bring regular supplies. At present, there are many serious difficulties of detail in the way of this consummation, but let us trust that the time is not distant when the British householder, aided by the practical popularisation of mechanical and chemical science, may find his best security against high food rates in the fact that his beef and mutton are fed at the Antipodes, and that some of his best bread and his choicest fruits are the products of South Australian fields and Tasmanian or New Zealand orchards.

(To be Continued.)

WHAT WILL BE THE FORM OF THE TRICYCLE?

By John Browning,

Treasurer of the London Tricycle Club.

THE number of tricycles known by different names has now reached over 300. These may be divided into two great classes: front-steerers and rear-steerers—or those machines which have the steering-wheel in front of the rider and those in which it is behind. It is but little known that Starley first brought out the Salvo as a hind-wheel steerer. After a few months he changed the construction to a front-steerer.

Soon after this, in the next season, the popular Meteor form came into vogue. This was extensively copied under various titles; but during last season and the present most of the makers who were making only hind-steering machines have produced new patterns of good front-steerers, while, as far as my knowledge extends, the makers who were making front-steering machines have confined their attention strictly to that type of tricycle. This leads us evidently to infer that machines having hind steering-wheels will become an extinct type in the immediate future.

Against this inference stands the fact that the fastest machine we have, the "Humber," is a rear-steerer, and that all the novel machines which have been introduced this season—the "Monarch," the "Arab," the "Rucker," and the "Sterling"—are of this construction.

Now, the "Monarch" may claim to be the tricycle reduced to its simplest possible form, having no more bearings than a bicycle. It is a true double-driver, both driving-wheels doing equal work. It can be made exceedingly light, and it is an admirable hill-climber, possibly the best known.

The "Rucker" is the first rear-steerer produced with the pedals in the right place, that is, under the rider, and behind the centres of the driving-wheels. It is a true double driver, and it has the best steering-gear of any machine made.

The Stirling, as well as its great novelty of driving the pedals backwards to urge the machine forward, by which friction is avoided and power in leverage from the direction in working is gained, has the seat suspended by straps from a frame, which is attached to the machine by strong helical springs. The same frame also carries the handles. With this machine, bad macadam—that terror of the tricyclist—may be ridden over and scarcely felt.

With machines, then, of the hind-wheel steering type, possessing such important advantages, it may well be asked—why are front-steerers gaining ground almost exclusively? There is a tolerably general belief that tricycles

XUM

with hind steering wheels are unsafe when riding down hill. It seems to me that the makers have themselves to thank for this belief; they mostly make the hind steering-wheel too small, and they always, for the sake of appearance, put the steering-wheel too close to the rider. This is in every way prejudicial to the working of the machine. By making the steering wheel larger a better contact is obtained and more hold is taken of the ground.

This point has been admirably carried out in the well-known "Facile" bicycle. Again, by making the backbone which carries the hind steering-wheel about nine or ten inches longer, the wheel would keep down better on the ground when running down hill; it would also pass more easily over obstructions on a rough road, and it would communicate much less vibration to the rider, because when rising itself it would, being farther from him, raise him through a smaller height. The longer the backbone is the better the machine will carry luggage, and it should be mentioned in this connection that, when laden with luggage for touring, a hind-wheel steering tricycle is made steadier and safer, and steers better, while the very reverse obtains with the front-wheel steering machines.

This season I have been riding only rear-steerers, with great pleasure and benefit myself, and I cannot help thinking that if manufacturers will make the two small, yet all important, alterations in them I have indicated, that they have a great future before them. It may be that they will require a little more time and attention to learn to ride them well than front-wheel steering machines, yet that will not be begrudged by those who wish to become experts, if they know that an advantage is to be gained thereby.

Hind-wheel steering machines are the most graceful in appearance, having nothing of the Bath-chair about them, and they are by far the easiest to mount and dismount from. They can be made lighter than front-steering machines, and lend themselves more readily to novel variations in construction. Every front-steering tricycle resembles strongly the first front-steerer introduced, the Salvo, whilst no such similarity exists among rear-steerers.

It may be that from being more readily ridden without any science, and from its being a stronger machine and more proof against ill-usage, that the greater number of the cheaper class of tricycles will be front-wheel steerers; but, as the desire will increase to catch up with their more nimble-footed brethren, the bicycles, while preserving as far as possible their own advantages, I think it most probable that the hind-wheel steering machines will be the high-class tricycles of the future.

PHOTOGRAPHY FOR AMATEURS.

By A. Brothers, F.R.A.S.

PART XII.

THE portrait of a friend taken by one's self, even if less perfect than one done in the carefully-arranged light of the professional photographer's room, is certain to possess more interest from the fact of its being our own work; and the amateur will have no difficulty in finding material on which to exercise his skill.

The desire to take portraits we may say is almost universal with the beginner in photography; and we propose now to show how he may obtain the best results. Something more than a map of the face is required, and it is not sufficient to place the sitter in the open air and without further preparation "take" the picture. The sitter should never be placed in full sunlight. Preferably the light should come from the north, and it should be arranged that one side of the face should be in shade. The outline of the nose should be seen against the cheek. The proper effect may be assisted by placing a screen on the shade side, and too much light from the top may be avoided by holding a screen covered with some light material over the head, and by careful arrangement of the two screens the best effect may be easily seen. Assistance may be required to uncap the lens, but if the screen be provided with a long handle, the operator may do without an assistant.

A word or two about *focussing* may be useful here. With portrait lenses all parts of the subject cannot be in perfect focus, therefore we must take an average, and this is best obtained by seeing that the eye nearest the lens is perfectly sharp, and the rest of the subject will be in fair average focus. The hands often give some difficulty. See that the sitter does not sit directly facing the camera, and that the hands are not too far forward. Let the figure be turned partly to the side if the hands are to be included, and see also that they are suitably "posed." The hands form an important part in a well-arranged portrait. A vignette presents few difficulties.

The background is an important matter. Foliage sometimes may be utilized, but if only a vignette be required, a large sheet of brown paper fixed at a suitable distance may be sufficient. The tone or colour of the background should be selected to suit the effect desired. Backgrounds painted on both sides in different colours can be purchased, and are very suitable. Sometimes a porch or conservatory may be utilized. Of course, with the quick gelatine plates, no head-rest will be required. Neither is it necessary to use a portrait lens, as in a good light a landscape lens will give very good results, although if the amateur possess the portrait lens he would use it for vignettes. The landscape lens should be preferred if foliage or other surrounding objects are to be introduced, owing to the greater depth of focus which such lenses give.

Excellent portraits may sometimes be obtained in an ordinary room, careful attention being given to lighting the subject. The sitter should not be too near the window, and the dark side of the face can be relieved by means of a reflector, which may be a sheet of white paper held at a suitable distance.

Before proceeding to print a portrait, the negative should be carefully examined, and all defects should be removed by means of lead-pencil or with some suitable pigment in water-colour, the object being to stop out the defects to the depth of the surrounding parts. Considerable skill is required to "retouch" a negative. There can be no doubt that a "retouched" portrait may be made smoother and prettier than an untouched print. Whether such retouching is legitimate may be a matter of question, but as the practice is now universal, an untouched portrait when placed beside one "improved" is apt to be compared unfavourably; therefore, if the amateur desire his work to be placed side by side with retouched portraits, he must work upon his negatives to produce the fashionable effect. The retouching is effected by working on the negative with lead-pencil cut to a very fine point and then rubbed on fine sand or emery paper. The negative must be rested on a suitable stand, with a strong light reflected through it. Obvious defects must first be removed, and then the skill of the retoucher must be exercised to produce the desired smoothness. This is done by carefully filling in the transparent places; and if increased high lights are required, the lead-pencil is applied to darken the parts. Our advice is to do as little as possible beyond removing real defects; a perfect photograph ought not to require the assistance of

the artist, and it should be the aim of the photographer to produce good photography.

Retouching on the negative should not be attempted until the varnish is quite hard. Pencils of different degrees of hardness will be needed, HHH, HH, HB, and B are all useful, and they should be of the best quality of lead.

Vignettes require careful attention in printing. A piece of cardboard should have an aperture cut roughly to the shape of the portrait required, but somewhat smaller. This cardboard shape should be placed about a quarter of an inch from the negative, outside the printing-frame. A piece of tissue-paper pasted over the aperture will soften the light and produce the vignette effect.

It might be supposed that the expansion of paper by moisture would be equal in all directions. Experience shows that this is not the case. It will sometimes be found after the prints are mounted that some are larger than others. This, of course, in a portrait, is a serious defect, as it makes the face too long or too broad, as the case may be. The prints having all been cut to the same size, it is easily seen when they are mounted if the paper in use produces the defect; and should such be the case, the prints must be allowed to become dry before mounting, and then, if the starch be applied quickly, the paper has not time to fully expand before it is attached to the mount. The defect referred to should be looked for, as unless the prints are compared with each other, it may escape notice, and the portrait would possibly be found to be defective in some way, and the true cause not be suspected.

Reviews.

GUIDE TO SOUTHAMPTON.*

This is a useful and cheap little guide to Southampton, written expressly for the visit of the British Association for the Advancement of Science (the particulars of which are given below). It contains an interesting sketch of the ancient history of Southampton; an account of the streets and public buildings, parks, quays, chapels, and so forth; a sketch of the shipping companies connected with the port; and a sufficient description of excursions, drives, and walks in the neighbourhood.

THE BRITISH ASSOCIATION.

The arrangements for the fifty-second annual meeting of this association, which is about to be held at Southampton, extending from Wednesday, the 23rd inst., to Thursday, the 31st, are now completed, and an elaborate official programme has been issued. The first general meeting will be held on Wednesday evening at the Victoria Skating Rink, when Sir John Lubbock will resign the chair to Dr. C. W. Siemens, and the president-elect will give his inaugural address. On Thursday evening there will be a *soirée* in the Hartley Institution at the invitation of the Local Executive Committee; on Friday evening a "Discourse on the Tides," by Sir William Thomson, M.A., in the Skating Rink; on Monday evening a discourse on "Pelagic Life," by Mr. H. N. Moseley, M.A., at the Skating Rink; on Tuesday evening a *soirée* at the Hartley Institution on the invitation of the Mayor and Corporation; and on Wednesday afternoon the concluding general meeting at the Skating Rink. The several sections will meet daily at 11 o'clock in the morning from Thursday to Tuesday, both inclusive, in various public buildings. The general committee will meet on the 23rd for the election of the President and sectional officers; on the 28th, to appoint officers for 1883 and the place of meeting in 1884; and on the 30th, when the report of the committee of recommendations will be received. On Saturday afternoon, the 26th, there will be five half-day excursions to various places of interest in the neighbourhood, including one to Broadlands and Romsey, where Lord Mount-Temple will entertain the visitors, and another to Netley Abbey and Hospital, where a garden-party is to be given by the Surgeon-General and officers of the Army Medical Department. On Thursday, the 31st, four whole-day excursions are arranged, some on water, and some on land. The Bishop of Truro will preach a sermon at St. Mary's Church on the morning of Sunday, the 27th, when the members and associates, with the Mayor and Corporation, will attend the service, and on the same morning the Rev. C. Pritchard, Savilian Professor of Astronomy at Oxford University, will preach at All Saints' Church. Canon Basil and Mrs. Wilberforce give a garden-party in the deanery grounds on Monday, the 28th, and on the evening of the same day the Provincial Grand Master of Hampshire and the Isle of Wight will offer a Masonic welcome to visiting brethren. The Queen has assented to an application for the members of the association to visit Osborne after her departure for Scotland, which will probably be about the 25th inst. Various other arrangements of a minor character have been made to give a proper reception to the Association during its visit. Outside the immediate engagements of the Association, a lecture to the operative classes is to be given in the Skating Rink on Saturday evening by Mr. John Evans, D.C.L., on "Unwritten History, and how to read it," the chair being taken by Dr. Siemens, the new president.

* "Guide to Southampton and Neighbourhood." By Thos. W. Shore, F.G.S., F.C.S. Published by Gutch & Cox, Southampton. Price Eightpence.

A LUMINOUS SHARK.

By C. F. Holder.

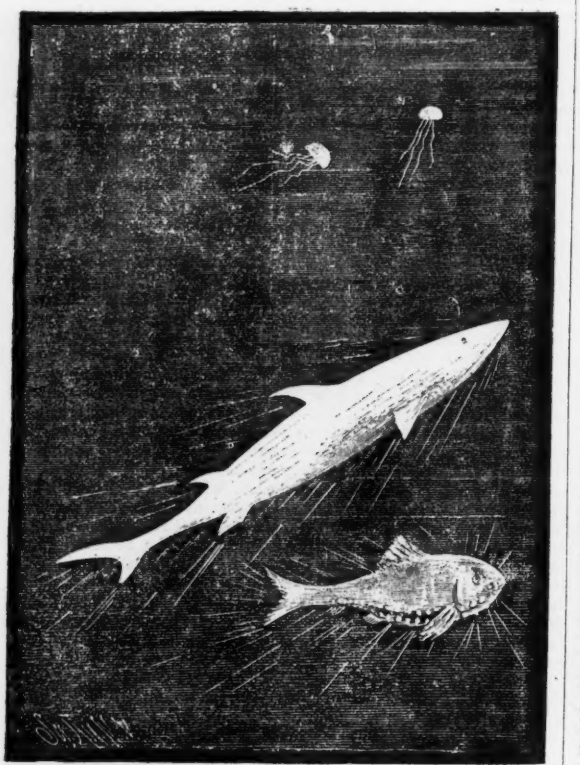
Among the later outgrowths of scientific investigation we find the theory of abysmal light, intended to explain the presence of eyes in many of the deep sea forms, their existence supposed to be conditional upon the presence of light in the greater depths of the ocean. The Ascidians and Alcyonarians are well known as wondrous light givers. The form of the former we are most familiar with is the oval ball that seems growing upon a stem, and waves to and fro with the tide like a veritable plant; it is, however, a highly organised animal. Some of the Ascidians are free swimmers, and live in colonies; such is the Pyrosoma, one of the most remarkable of all phosphorescent creatures, as well as one of the largest. In appearance they resemble an elongated empty barrel, about 5 ft. long as a maximum, with one end closed, the other open, a provision that insures movement in a given direction. The means of propulsion seems incomprehensible, but it is easily explained, however, upon an examination of the animal. Each individual in the colony draws in water from the outside and ejects it into the interior, where it finds a common outlet at the open end, the current rushing out forcing the aggregation of Ascidians along in the direction it happens to take. The surface is completely covered with curious filaments that appear to wave to and fro. Such is the general appearance of the creature in the daytime, but in the night or abysmal depths of the ocean it presents an entirely different sight, gleaming and glowing with a wondrous golden light, that penetrates the water for twenty or thirty feet around it, and resembling more than anything else a cylinder at white heat, vibrating waves seeming to pass over it in quick succession, producing many different tints of yellow and gold. As may be surmised, at a distance of one hundred feet or more they resemble worms three or four feet in diameter, of wavy, nebulous matter, the centre burning brightly. The appearance of numbers of these wondrous creatures in the water is an extraordinary sight, and looking down into the depths we seem to be looking into space. Every break of the water is the signal for myriads of beautiful creatures to spring into life, as it were, the sea fairly igniting the minute granules in the depths below sparkling and scintillating in the reflection. Great constellations seem revolving in erratic courses, now rising and falling, meeting each other, the lights intermingling, while smaller phosphorescent jelly fishes, like stars of lesser magnitude, revolve about them, completing the curious scene. The light given out by the Pyrosoma is not confined to the water, but is reflected above it, covering everything with a pale, ghostly light. The sails of vessels are lighted up by it, and cast dark shadows about, while within four or five feet of the animal a newspaper can be read with perfect ease.

But the most curious light-giving forms discovered are the fishes. Among the bony fishes of great depths, the families Scopelids, Sternoptychids, and Stomiatids have long attracted attention, on account of the rows of bright spots that occur upon their sides, now found to be luminous. These are found especially upon the fishes *Chauliodus Sloani*, *Stomias boa*, *Scopelus Humboldti*, &c. In

the *Ichthyococcus ornatus* and *Scopelus Rafinesquii* they are specially abundant. In one species of the former a large luminous spot occurs upon the front of the head.

The distinguished naturalist of the *Challenger* expedition, Willemoes-Suhm, now deceased, saw Scopelius phosphorescent in the night, of which he says: "One of them hung in the net like a shining star as it came out of the darkness. Possibly the seat of the light is in the peculiar side organs, and it may be that this phosphorescence is the only source of light in the great depths of the sea."

The thought that in the dark abysses of the deep sea every animal carries its lantern, as the miner carries his lamp on his head, is a very fascinating one; and, indeed, Herr Willemoes-Suhm observed several other fishes that were provided on the smooth head and on the head-beard with a "remarkably large sense organ." Valenciennes has also remarked of the genus *Hemiramphus* that it bears a strongly glittering phosphorescent pustule on the tip of its tail.



LUMINOUS SHARK (*Squalus fulgens*). FISH WITH PHOSPHORESCENT SPOTS (*Ichthyococcus ornatus*).

Among the fishes discovered by the *Challenger* expedition was the *Echiotoma microdon*, a dark fish from two miles beneath the surface. Below its eyes were two luminous spots; a narrow elongated one above the maxillary, and a small, short organ nearer the eye.

Another species, the *Micripnus*, had long fringed barbels; luminous spots above the maxillary, small and round. This was found on the Australian coast in 2,150 fathoms.

A stomatoid fish, Bathyophis, found over three miles below the surface, had long barbels; small luminous organs above the middle of the upper jaw, and a number of others along each side of the abdomen; also on the tail and outer ventral rays.

In the Ipnops the body was long, covered with cylindrical scales, and devoid of luminous organs. The head was depressed, long, and spatulate, its entire upper surface occupied by a remarkable phosphorescent organ that was longitudinally divided into two symmetrical halves.

The most remarkable light-giving fish, however, is a shark, a species of *Scymnus*, and allied to our morse of the southern coast, discovered by Dr. Bennett in Australian waters. The light in this case was universal. In relation to his find, Dr. Bennett says:—

"When the larger specimen, taken at night, was removed into a dark apartment, it afforded a very extraordinary spectacle. The entire inferior surface of the body and head emitted a vivid and greenish phosphorescent gleam, imparting to the creature, by its own light, a truly ghastly and terrific appearance. The luminous effect was constant, and not perceptibly increased by agitation or friction. I thought at one time it shone brighter when the fish struggled, but I was not satisfied that such was the fact. When the shark expired (which was not until it had been out of the water more than three hours) the luminous appearance faded entirely from the abdomen, and more gradually from other parts, lingering the longest around the jaws and on the fins.

"The only part of the under surface of the animal which was free from luminosity was the black collar around the throat; and while the inferior surface of the pectoral, anal, and caudal fins shone with splendour, the superior surface (including the upper lobe of the tail fin) was in darkness, as also were the dorsal fins, back, and summit of the head.

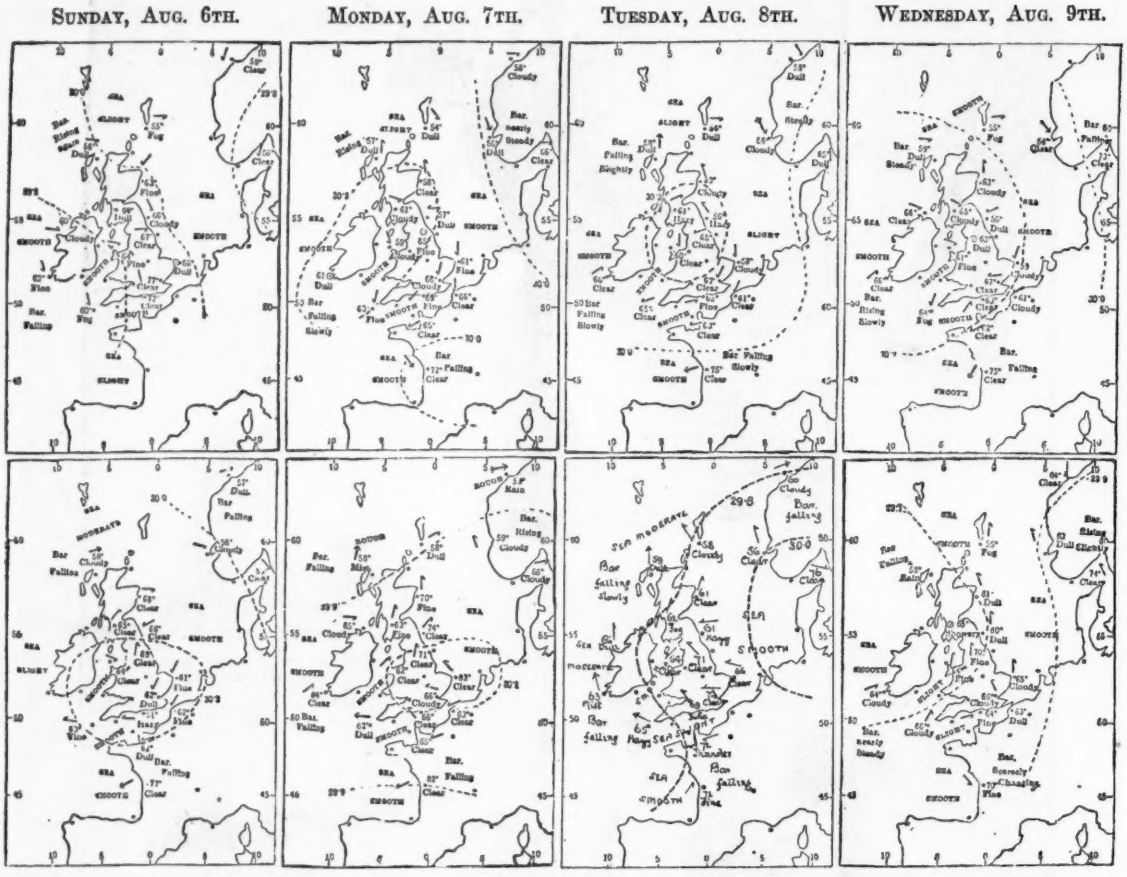
"I am inclined to believe that the luminous power of this shark resides in a peculiar secretion from the skin. It was my first impression that the fish had accidentally contracted some phosphorescent matter from the sea, or from the net in which it was captured, but the most rigid investigation did not confirm this suspicion, while the uniformity with which the luminous gleam occupied certain portions of the body and fins, its performance during life, and decline and cessation upon the approach and occurrence of death, did not leave a doubt in my mind that it was a vital principle essential to the economy of the animal. The smallness of the fins would appear to denote that this fish is not active in swimming; and, since it is highly predaceous, and evidently of nocturnal habits, we may perhaps indulge in the hypothesis that the phosphorescent power it possesses is of use to attract its prey, upon the same principle as the Polynesian Islanders and others employ torches in night fishing."—*Scientific American.*

THE CHARMS OF SWORDFISHING.

NOW that whaling has to so large an extent ceased to be the important industry it once was, the most exciting sport which the hardy fishermen of Nantucket and Martha's Vineyard find left to them is the catching of swordfish. The name of this fish describes its most peculiar feature, the possession of a long and sharp sword attached to the snout, and, although it cuts but a small figure beside the whale in point of size, it does not yield to the more ponderous denizen of the deep in the reckless daring with which it fights for life when attacked. A schooner designed for the capture of swordfish is provided with a "pulpit," which is the name given to a little platform built on the extreme point of the bowsprit, about three and one-half feet in height, and having a semi-circular iron strap, supported by stanchions. When a fish is sighted by the look-out, who stands on a sort of platform affixed to the head of the foremast, the vessel is brought as near as possible, and then the captain takes his place on the "pulpit," armed with a harpoon. The barb of the harpoon, which is about six inches in length, is backed with an iron pocket in which the iron shank rests, and the shank is attached to the vessel by a short line, by which it is freed from the fish when he is struck. In order to secure a great swordfish the barb must be driven right through him. Then when the shank comes out and the line is pulled taut, the barb "toggles on," as the fishermen call it—that is to say, it catches on the other side, and no effort of the victim will free him from the line. When the fish feels the sharp iron penetrating his flesh, he usually springs half out of the sea, then plunges back into the depths and makes off so fast that water has to be poured over the line attached to the harpoon as it runs out from the boat to prevent its catching fire. When the fish finally comes to a standstill, the men begin to draw in the line. Sometimes all will go well until the monster is brought alongside, while again the fish, after being drawn well in, will dash off afresh with such speed that the men hauling the line will be shot over the side into the sea. Even when he has finally been dragged near the vessel, the fish may suddenly summon all his energy and rush upon the craft with a violence which will shake it from stem to stern, and if he succeeds in hitting it with his sword, may drive a hole through which the water will pour in. Gradually, however, his strength is exhausted with the constant loss of blood, and at last he is hauled alongside, when two iron "landers," resembling boat-hooks, and having curved steel hooks at the extremities, are handed over the side and thrust into his gills. By the use of these his great head is held, while a stalwart sailor climbs down over the side with the "thumper," a weapon between a tomahawk and a sledge-hammer, and gives him a series of ponderous blows between the eyes, despite his struggles. Then a great hook is get over his

SWORD-FISHING OFF BLOCK ISLAND.
(From Sketches by Joseph Becker.)

WEATHER CHARTS FOR WEEK ENDING SUNDAY, AUG. 13.



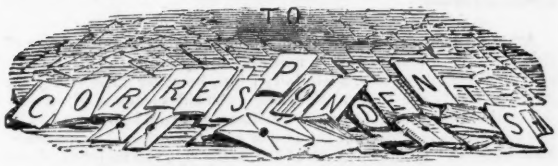
In the above charts the dotted lines are "isobars," or lines of equal barometrical pressure, the values which they indicate being given in figures at the end, thus—30·4. The shade temperature is given in figures for several places on the coast, and the weather is recorded in words. The arrows fly with the wind, the force of which is shown by the number of barbs and feathers, thus:— ⟶, light; ⟶, fresh or strong; ⟶, a gale; ⟶, a violent gale; ⊙ signifies calm. The state of the sea is noted in capital letters. The * denotes the various stations. The hour for which each chart is drawn is 6 p.m.

wide, extending, crescent-shaped tail, the throat halyards are brought into requisition, and he is hoisted aboard, although he may yet make one or two desperate flaps before he dies. When several fish are sighted at once, a crew will not wait for the death of one before attacking another, but buoy him by means of a water-tight barrel, having a ring attached to two lines wound tightly around it. This is bent into the line as it is run out by the fish, and then the barrel is thrown overboard. The fish is always puzzled to make out what this means, but all his struggles to escape from it prove fruitless, and at last the barrel floats calmly upon the water, pointing out to the fishermen where their victim lies. A good-sized swordfish is 15 ft. in length, and weighs about 700 lb. Fine, juicy steaks are secured from it, which command a good price in the market, and a schooner which has good fortune off the Nantucket coast can carry to Boston a load which will well repay the crew.

THE PUBLIC HEALTH.

THE Registrar-General's weekly return shows that the annual rate of mortality last week in 28 of the largest English towns averaged 20·1 per 1,000 of their aggregate population, which is estimated at 8,469,571 persons in the middle of this year. The six healthiest places were Derby, Halifax, Brighton, Bristol, Cardiff, and Plymouth. In London 2,546 births and 1,370 deaths were registered. Allowing for increase of population, the births exceeded by eight, whereas the deaths were no fewer than 353 below, the average numbers in the corresponding week of the last ten years. The annual death-rate from all causes, which had been equal to 17·7 and 18·8 per 1,000 in the two preceding weeks declined again last week to 18·4. During the first five weeks of the current quarter the death-rate averaged only 18·1 per 1,000, against 21·3 and 24·7 in the corresponding periods of 1880 and 1881. The 1,370 deaths included 1 from small-pox, 33 from measles, 38 from scarlet fever, 15 from diphtheria, 57 from whooping cough, 1 from typhus fever, 13 from enteric fever, 118 from diarrhœa and dysentery, and 6 from simple cholera; thus, 282 deaths were referred to these diseases, being no fewer than 235 below the corrected average number in the corresponding week of the last ten years. Different forms of violence caused 47 deaths; 39 were the result of negligence or accident, among which were 17 from fractures and contusions, 3 from burns and scalds, 13 from drowning, and 4 of infants under one year of age from suffocation. The 17 deaths from fractures and contusions were thus caused:—Male, aged 15 years, and female, 5, run over by van; males, 58 and 72, run over by cart; male, 34, crushed by van; male, 21, crushed under horse; male, 61, run over on Great Eastern Railway; male, 20, run over on Midland Railway; male, 48, run over on railway at Gunnersbury; female, 52, fell down stairs (intoxicated);

male, 2, fell from chair; male, 41, by fall in passage; male, 19, fell from scaffold; males, 2 and 4, by fall; male, 14, injured by machinery; and male, 4, by blow. An inquest was held in each of these seventeen cases. Seven cases of suicide were registered. In Greater London 3,288 births and 1,671 deaths were registered, equal to annual rates of 35·1 and 17·8 per 1,000 of the population. In the Outer Ring twenty-one deaths were referred to diarrhœa, including ten in the district of West Ham. Four fatal cases of diphtheria occurred in Harrow sub-district.—*Times.*



Letters to the Editor.

[*The Editor does not hold himself responsible for the opinions of his correspondents. He cannot undertake to return manuscripts or to correspond with their writers. All communications should be as short as possible, consistently with full and clear statements of the writer's meaning.*]

All Editorial communications should be addressed to the Editor of KNOWLEDGE: *all Business communications to the Publishers, at the Office, 74, Great Queen-street, W.C.*

All Remittances, Cheques, and Post-Office Orders should be made payable to Messrs. Wyman & Sons.

**** All letters to the Editor will be Numbered. For convenience of reference, correspondents, when referring to any letter, will oblige by mentioning its number and the page on which it appears.*

"In knowledge, that man only is to be contemned and despised who is not in a state of transition. . . . . Nor is there anything more adverse to accuracy than fixity of opinion."—*Faraday.*

"Show me a man who makes no mistakes, and I will show you a man who has done nothing."—*Liebig.*

STIMULANTS AND WORK.

[514]—I have just read your quotation from the Abbé Moigno (page 142) and your own comments thereon. I have tried experiments very similar to those you describe, with exactly the same results; in fact, so far as intellectual work is concerned, I might describe my own experience by direct plagiarism of your words.

Besides these, I have tried other experiments which may be interesting to those who, without any partizan fanaticism, are seeking for practical guidance on this subject.

As many of your readers may know, I have been (when of smaller girth) an energetic pedestrian, have walked over a large part of England, Scotland, Wales, and Ireland, crossed France twice on foot, done Switzerland and the Tyrol pretty exhaustively; in one walk from Paris taking in on the way the popular lions of the Alps, and then proceeding, *viâ* Milan and Genoa, to Florence, Rome, Naples, and Calabria, then from Messina to Syracuse, and on to the East. All this, excepting the East, on foot. At another time from Venice to Milan, besides a multitude of minor tours, and my well-known walk through Norway.

In the course of these, my usual average rate, when in fair training, was 200 miles per week. The alcohol experiments consisted in doing a fortnight at this rate on water, scrupulously abstaining from any alcoholic drink whatever, and then a fortnight using the beverages of the country in ordinary moderate quantity. I have thus used British ales and porter, Bavarian beer, French wines, Italian wines, Hungarian wine in the Tyrol, Christiania öl, &c., according to circumstances, and the result has been the same, or with very little variation. With the stimulant I have, of course, obtained a temporary exhiliration that was pleasant enough while it lasted, but after the first week I found myself dragging through the last few miles, and quite able to appreciate the common habit of halting at a roadside "pub" or wine-shop, for a drink on the way. No such inclination came upon me when my only beverage was water, or water plus a cup of coffee for breakfast *only* (no afternoon tea). Then I came in fresh, usually finishing at the best pace of the day, enjoying the brisk exercise in cool evening air. Physical work of this kind admits of accurate measurement, and I was careful to equalise the average of these experimental comparative fortnights.

The result is a firm conviction that the only beverage for obtaining the maximum work out of any piece of human machinery is water, as pure as possible; that all other beverages (including even tea and coffee) ginger-beer, and all such concoctions as the so-called "temperance drinks," are prejudicial to anybody not under medical treatment. To a sound-bodied man there is no danger in drinking any quantity of cold water in the hottest weather, provided *it is swallowed slowly.* I have drunk as much as a dozen quarts in the course of a stiff mountain climb when perspiring profusely, and never suffered the slightest inconvenience, but, on the contrary, have found that the perspiration promoted by frequent and copious libations at the mountain streams enabled me to vigorously enjoy the roasting heat of sun-rays striking so freely and fiercely as they do through the thin air on the southward slopes of a high mountain.

I am not a teetotaler, and enjoy a glass of light wine, but always take it as I sucked lollypops when a child, not because "it is good for my complaint," or any such humbug, but simply because I am so low in the scale of creation, as imperfect, as far from angelic, as to be capable of occasionally enjoying a certain amount of purely sensual indulgence, and of doing so from nothing higher than purely sensual motives.

If all would admit this, and freely confess that their drinking or smoking, however moderate, is simply a folly or a vice,* they would be far less liable to go to excess than when they befool themselves by inventing excuses that cover their weaknesses with a flimsy disguise of medicinal necessity, or other pretended advantage. In all such cases the physical mischief of the alcohol is supplemented by the moral corruption of habitual hypocrisy.

W. MATTIEU WILLIAMS.

* [All the rest of Mr. Williams's letter is so very sensible and so very much to the point, that I must confess I read with extreme surprise a sentence which implies what I cannot but regard as utterly wrong, and worse than wrong. My esteemed friend in his extreme love of honesty and plain speaking, wants those who do as he does, to push honesty to a point which is, I take it, uncommonly near humbug and hypocrisy. In the first place *all* need not admit even that their taking daily a little wine or spirit, or ale, or cyder, is a mere indulgence, for it is certain there are tens of thousands who honestly believe the moderate use of alcoholic stimulants to be essential to their health, and there are thousands who have proved this by carefully watched experiment. But if we set these on one side and consider only those who take an occasional glass or smoke an occasional cigar, because they like it, because it gives them a certain amount of pleasure, doing them so far as they can judge no harm whatever, why should these, of whom I confess I am one, admit and freely confess that their drinking, however moderate, is simply a folly or a vice? Where does the folly or the vice come in? It seems to me uncommonly sensible to take any pleasure which hurts no one, including one's self. I am in the habit of regarding a man who denounces his fellows for taking innocent pleasures, and calls those pleasures follies or vices, as a mischievous hypocrite,—generally as a man who strives to hide real wickedness, by which I mean wrong-doing to others, or selfish disregard for their interests, by pretended zeal about trifles, which are not even triflingly wrong, but perfectly innocent. The man who warns one whom he knows to be weak from the social glass I respect; the man who tells another whom he knows to have a good average amount of common sense and strength that he is a fool or vicious if he takes a social glass, I assume at once to be a humbug and a hypocrite, for in no other way can his action be explained: and experience shows the interpretation to be systematically correct. What, then, should we think of a man who says as much of himself? But, apart from this, the general principle that pleasures are follies or vices merely because they are pleasures of the senses only, is an outrage on common sense. Life is full of pains and sorrows, cares, anxieties, and occasions for self-sacrifice; it also affords opportunities for many pleasures of all classes—emotional, sensorial, intellectual; not to take these when one may without injury or loss to others or one's self, is the only folly I see in connection with them, to whatever class they may belong. To imagine there is wisdom in rejecting them—unless it be for the sake of others—is utter folly; to imagine that a Being of infinite wisdom, who so made us that we cannot live our lives without sorrow and suffering, takes pleasure in seeing His creatures reject such innocent pleasures as lie in their way, seems to me much nearer blasphemy than much that goes by that name. —ED.]

THE LIBRATION OF SENSATION.

[515]—In my little book, "The Revised Theory of Light," I showed that the received explanation of the phenomena of the *ocular spectra* is full of discrepancies, and inadequate. And in that work and previous lectures I ventured to substitute my hypothesis of the Libration of Sensation, by which title I seek to express that tendency of the nervous system to oscillate from one extreme to an opposite condition, in the ratio in which the initial sensation was a departure from the nervous system's normal state. This law of *libration* or reaction might be shown to hold throughout the whole human constitution. A point of contact is thus established between the organisations of the macrocosm and microcosm. They are

XUM

linked by the great law of *compensation*, by the law of the equitable distribution of force, which may be thus stated, viz., that whatever aberration takes place in excess of a *mean* state must be rectified by an equal [?] and opposite one in defect, and *vice versâ*, or well-being would be imperilled.

The fact that the sentient eye is the only "colour-box," and that external to it there are but mechanical vibrations of different periodicities, is not sufficiently present to men's minds to prevent them from reasoning as if colour were a property of the vibrations themselves. This has been the case with respect to the explanation of the *ocular spectra*; the phenomena have been regarded as external effects, instead of internal, and due to the reactions of the nervous system; they are sequent sensations which may be perceived, though the eye be closed against all external vibratory action. An initial sensation of a black spot in a white field is succeeded by one of a white spot in a black field. A sensation of a dark colour in a white field, by its light complementary sensation in a dark field, and *vice versâ*.

We find, then, that the changes in the sense of colour which are produced by the cooling of beads, and which were alluded to by a correspondent in a recent number of KNOWLEDGE, also occur in the retina by the reactions which take place after an initial sensation. The complementary *spectra* are entirely subjective phenomena. After a very strong initial sensation of light, the sequent spectra endure for a sufficient length of time to enable anyone to experiment with them. For instance, after being dazed by the sun, any sequent spectrum, say dark green in a light field, will appear light red in a dark field, and become dark green again in a light field,—here, then, are instances of the vibratory reactions within the nervous system producing different sensations of colour.

W. CAVE THOMAS.

HERNIA AND TRICYCLING.

[516]—Dr. B. W. Richardson is altogether mistaken about this. I am 68 years of age, and have had hernia on both sides for 30 years. When 64 I commenced to ride a tricycle, riding daily three miles to business and three miles back, without the slightest inconvenience. I ought to say that I wear a Cole's double truss. This time of the year I enjoy three or four games of bowls every fine evening with impunity.

E. K.

SINGULAR RAINBOW.

[517]—I do not know whether I am contributing anything to KNOWLEDGE, but what I have to relate is quite new to me. A thunder-shower was approaching us the other evening. A most brilliant and perfect rainbow was formed with a secondary bow, also very bright, but in addition, between the two was a third, in the shape of an ellipse, with the colours in the same order as those of the primary, and touching this near the ground. It was not sufficiently perfect for me to see whether it touched the secondary bow, but I think that if it had been perfect it would have done so.

J. F. ROUNTHWAITE.

HAIR TURNING GREY.

[518]—My grandfather was surgeon of H.M.S. *Ardent* at the battle of Copenhagen. One of his assistants (a young man who had only just joined the service when the fleet sailed for the Baltic) was so overpowered with fear that he cowered down stupefied during the whole of the engagement, and his hair, which was dark, became white. I have frequently heard my father, himself a naval surgeon, refer to this case, and I believe it to be strictly true.

J. THOMSON.

28 *July*, 1882.

EFFECTS OF LIGHTNING.

[519]—In a thunderstorm which I witnessed near Berryville, Virginia, July, 1879, a wooden house with iron stove and pipe was struck, and a woman killed. On examining the structure I found three places where the wooden boards of the walls were smashed outwards just at the level of the floor. Rough, jagged holes had been pierced, the current, which entered by the stove-pipe, having divided, and left the house on three sides. One of the tracks could be traced to a well about six yards distant, down which the discharge passed.

G. R. WYNNE.

A POWERFUL electric light on the steamer *Rosebud* created an immense sensation among the Indians at Fort Berthold, in Dakota. The light was turned upon a group on the shore, when they were paralysed for a moment, and then they set up a dismal chant, lay down and rolled, and were with difficulty pacified. They called it the white man's big moon medicine.

Answers to Correspondents.

**** All communications for the Editor requiring early attention should reach the Office on or before the Saturday preceding the current issue of* KNOWLEDGE, *the increasing circulation of which compels us to go to press early in the week.*

HINTS TO CORRESPONDENTS.—*1. No questions asking for scientific information can be answered through the post. 2 Letters sent to the Editor for correspondents cannot be forwarded, nor can the names or addresses of correspondents be given in answer to private inquiries. 3. Correspondents should write on one side only of the paper, and put drawings on a separate leaf. 4. Each letter should have a title, and in replying to a letter, reference should be made to its number, the page on which it appears, and its title.*

ALLEYNE REYNOLDS. Our paradox corner is not for paradoxes of that sort. The one you quote naturally arises from the initial $x = x + 1$. Whence, you say, x = infinity; but, however large x may be, $x + 1 - x$ is always unity. Squaring both sides leads to $x^2 = x^2 + 2x + 1$; whence $x = -\frac{1}{2}$; but were x infinite, you could no more cancel the two terms x^2 here than the two x's in the original equation.—PAGET HIGGS. Quaternions would scarcely suit the majority of our readers.—HY. BOWMAN. Fear space will not permit. The influence of moon on weather is a very prolific subject. I can, from my own experience, affirm that no two believers have identical views.—H. NELSON. Only experienced engravers could say whether a spectacle or an eyeglass would best suit a "wood engraver, who is frequently prevented from working by the lines on the block becoming misty and indistinct." Bicycling is not supposed to have any special influence on the eyes.—F. P. Mr. Allen, in using the word "wish," neither means "an intelligent desire" nor only that a special feature *is* presented. He means that the colours of petals differ in different species according to the kind of insects which it is good for each plant to attract. He supposes his readers not wholly wanting in imagination. When a writer on the ivy speaks of it as clinging, say, to an oak, does he mean that the plant is capable of an intelligent clasp?—E. C. H. You are right. I had not noticed the date. I was so startled by Edward being called the twenty-fifth king that I quite overlooked the wrong date. Those cigars must have left their effect on the good Abbé, even to this very day.—G. R. SMITH, L. Colmbly, E. Underwood, J. M. Hargreave, K. Smiles, R. F. Grierson, and others. We cannot undertake to solve problems. They come in in too great numbers.—FUSEE. I regret to hear you are among surroundings so unfavourable to chess. The position of a chess-player who can get no one to play with him at any game but draughts is truly lamentable. I wish I knew of any book on Draughts like Staunton on Chess—not for my own sake (for draughts seems to me a very monotonous amusement)—but that I might tell you.—M. B. A. Neither can science understand the attraction of gravity.—W. B. W. You jump rather hastily at our expression "angry with the drunkards," asking if anger is the best spirit in which to try to repress crime, and speaking of revenge, &c. I used the word rather as implying strong objection than any feeling of personal animosity. Are you quite consistent? You are going to be a total abstainer, though not one of those who are tempted to drink; yet you will not join the Blue Ribbon Army. How, then, is your abstinence going to do any good? Now if wearing a blue ribbon meant—let us say—that the wearer was a reformed drunkard, there might be some pluck and credit in donning the symbol.—E. H. STEVENS. A cyclone is understood in meteorological phrase to mean, not a storm, but a region of low pressure or barometrical depression; an anti-cyclone to mean a region of high pressure. The terms are ill-chosen.—J. DEAS. Letter marked for insertion.—G. H. T. The inner satellite of Mars goes round the planet in less time than the planet takes to revolve on its axis, because the satellite is within the distance at which the period of revolution would be equal to that of the planet's rotation. This, however, is rather *how* than *why*. I cannot say why some comets revolve round the sun in different directions from the planets. If they all went the same way as the planets I could not tell you why that was, either. The moon can only cause the earth to rotate more slowly by exerting an action, the reaction corresponding to which increases the moon's distance.—W. ARNISON SLATER. I am interested to learn from the Paris *Figaro* that "Un Astronome Anglais, M. Proctor, pense qu'ils" (c'est à dire, les canaux supposés de Mars), "sont dus à l'industrie des habitants." It is a shame, I think, that M. Proctor never told *me* he thought so. — J. F. SIMPSON. Many thanks. Your communication unfortunately arrived when we were very much in arrears with our correspondence. Fear we can hardly find room for the notice you suggest; but if you could draw up a short one, would try to insert.—PARALLAX. These angles are the colatitudes of Greenwich and the Cape, namely, 39° 0′ and 56° 5′ respectively.—CHARON. Do not know how assistants are appointed to Observatories and Nautical Almanac Office.—H. W. FAUCUS. It was the conception that in or near the place where the disturbance occurs there is an explosive mixture of

oxygen and hydrogen, in sufficient quantities, to which I referred. You seemed to forget that observers have repeatedly been before, during and after thunderstorms, in the very region where this peculiar constitution of the atmosphere should have existed, if you are right.—Canadensis. Your suggestion is excellent. As to the P.D. theory, it really seemed too bad to keep all J. M.'s effusions for my own particular edification.—J. M. G. The subjects of your first three queries will be very suitable for future *articles*, scarcely for replies here. (4) There are not half-a-dozen stars whose distance can be regarded as determined. I place no reliance myself on any parallax but one—that of Alpha Centauri. (5) Let earth's mass be $81m$, moon's mass m, distance of earth's centre from moon's d; let x be distance from moon where attractions neutralised. Then by the known law of gravity $m \div x^2 = 81m \div (d-x)^2$; whence $x : d-x :: 1 : 9$; or $x : d :: 1 : 10$; thus the body's distance from the moon must be one-tenth the earth's.—Arthur Black. You have rather misapprehended my reply to "Gradatim," and the nature of the question he asked (naturally enough, as my answer was meant for him only). "Gradatim's" original query referred to a passage in Clerk Maxwell's little book on matter and motion, on referring to which you will find that the point you mention is fully considered. I wrote knowing "Gradatim" knew this. All these "answers" are to be read as replies to individual querists, not as independent statements.—Wm. J. Logerman (?). (1) I cannot remember receiving the letter you refer to. The subject, as you describe it, would not have suited these pages; but you may be assured your kind offer would not have passed wholly unnoticed. (2) Our electrical contributor added the remark that accidents of that kind (from lightning) are of great importance—I suppose in connection with the subject of risks from electric lighting. (3) Thanks for note that Evora (town in Portugal) is pronounced Ayvŏrah—accent on first syllable very strong, so that the two next are very short. (4) We by no means peevishly limit Knowledge to the abstract sciences. Cricket is a fit subject for our pages in the same sense that it is a fit subject for literature. You say, "If cricket is a fit subject for Knowledge, could you not find place for an occasional paper on 'Philology, the science of languages?'" Why, certainly; we could even do that if cricket were an unfit subject (also for an occasional paper on Logic).—Boyd Moss, F.R.C.S. It is only vivisection so intended and so regulated that has ever found approval here.—Charles Lassalle. No, I do not "suppose you require any puffings of your works"; because none of them have been sent to the office of Knowledge for review, far less for "puffings." Articles which, as I judge, have already been sent to other quarters, have reached me, with certificates, laudatory comments, and so forth. Should I have inserted the articles, or the certificates, or both?—W. S. Montague. I would use Todhunter, I think, for study; but read Williamson's, as treating the same subject from a different standpoint.—Hon. Sec. Have inserted your query, not feeling competent to express an opinion.—S. W. Desires to learn how to fumigate mahogany or oak wood, so as to give a deep rich colour and tone to new wood.—John J. Norrin, Jun. The energy is expended in both ways. First, on the brake as it checks and finally stops the turning motion of the wheels; then on the rails as they check and finally stop the advancing motion of the unturning wheels.—Zypero. Scarcely sufficient evidence given to show that that is the sole and true cause of Fairy Rings.—W. H. Stone. Alas, how can we find room?—T. W. W. Would much rather say "T. W. W. Yes." Would it be long?—C. O. The subject of "mnemotechnic formulæ," is, I agree with you, well suited to Knowledge.—C. J. B. In both cases the denser body falls fastest; because in each case there is a certain amount of resistance to overcome in falling: the heavier body, having the greater momentum, does the work soonest. Only in a vacuum does a light body of the same shape and size fall in same time through a given distance from rest as a heavier body.—Blind-worm. (1) Astronomy knows no Vulcan. (2) I do not insist on the sun being inhabited when cool enough. Without a special warmer and light-giver he might not be a very comfortable world. Perhaps there might be inherent warmth enough for all practical purposes, and a proper amount of light might shine from his interior, through suitable apertures on large masses of floating cloud. I do not know how this will be arranged.—J. C. Lloyd. It is not certainly known at what time the Mammoth lived. Analysis of water, if we have space, later. Can scarcely find time for discussing specimens of flowers sent for identification.

BOTANICAL.

H. H. H. (Liverpool). I do not know how to make skeleton leaves, but I believe you will find a recipe in the book called "Enquire Within." Corcagiensis (Cork). *Soldinella alpina* is a plant of the primrose family, closely allied to *Dodecatheon*, the so-called American primrose. It is not related to the Edelweiss. The botanical name of the Papaw tree is *Carica papaya*. I have often heard that its leaves have the power of making tough beefsteak tender, but I never experimented upon it, though it grew in my garden in Jamaica. This is the first time, however, that I have ever heard of its use in preventing meat from decomposing, and I suspect that your informant was mistaken. The leaves, pressed against the head, make an excellent cold compress for the headache.—High School (Nottingham). I don't quite understand the nature of your objection to the phrase "double calyx." I see it is used by Mr. Bentham, and, I think, by all other botanists. The calyx of potentilla is double, because it consist of five sepals, alternating with five external bracts. Of course, if you choose, you can say the bracts are not part of the calyx; and if so minded, you may call them an involucel. But I don't see that it matters as far as the facts are concerned; everybody would understand at once what one means. On the whole, I prefer the old statement that language is meant to express our thoughts, to Talleyrand's amended version.—G. O. Dephaga. To preserve plants, first, if possible, get a perfect specimen, *i.e.*, one with root, stem, leaves, flowers, and fruit together; but as this is sometimes practically inconvenient (for example, in an oak or even a cherry tree), get as near it as you can. Lay it flat between several sheets of coarse, unsized paper (*not* blotting-paper), taking care to place the parts as separate as possible. Press it with a big, heavy book. Change the paper once or twice, till the plant is dry. Thick-stemmed and thick-leaved specimens may be split with a knife. Very succulent plants may be dipped in boiling water; but the flowers must not be immersed. You had better try Bentham's 'British Flora," which will not only give you full instructions for preserving specimens, but will also enable you to identify all flowering plants, ferns, horsetails, or club-mosses, indigenous or naturalised, in the British Isles. But you must be prepared to take a little trouble.—A Reader (London-street, Edinburgh). Sporting in cultivated turnips may be due to any of three causes—first, to reversion; second, and most frequently, to changed conditions of soil, climate, manuring, &c. (for all plants sport most often under cultivation); and third, to hybridisation by insects with the other cultivated varieties of *Brassica campestris*, namely, swedes and rape-seed, or with closely-related wild species, such as charlock; but this last cause would, I think, operate less often. It is impossible to be sure in any case, except by isolating your causes. You may experiment for yourself, but where the conditions have occurred spontaneously you can only surmise.

CHEMICAL.

X. Y. Z. The papers, according to your description, are prepared correctly; but the indications afforded are uncertain, as other causes affect the paper. Thus, the rapidity of the action is modified by the humidity and temperature of the air; further, paper once coloured becomes again decolourised by exposure. Other gases also liberate the iodine, and thus colour the starch. Houzeau prefers litmus paper, slightly reddened, and impregnated with potassium iodide; this paper is rendered blue by ozone, the same colour not being produced by any gas except ammonia.—F. T. Drake. It is not wise to inhale or administer laughing gas, except by and with the advice of a medical man or other person duly experienced in the use of the gas (such as a qualified dentist). The gas, when required for breathing purposes, should also be prepared and purified by a competent chemist.

Our Mathematical Column.

EASY LESSONS IN THE DIFFERENTIAL CALCULUS.

No. VIII.

By Richard A. Proctor.

THE following examples may serve conveniently to illustrate the application of even the first principles of the differential calculus to problems which otherwise would present considerable difficulty:—

Problem I.—*The captain of a racing boat has a vacancy in his crew, and is desirous of so filling it as to counterpoise the boat as much as possible on the side of the new comer. The breadth of the thwart to be filled is 2ft.; assuming a man's weight to be proportional to the cube of the linear distance he occupies on the thwart, and that a man who would occupy but half the thwart weighs six stone, what would be the best weight for the new oarsman?*

Fig. 3.

Let A C, Fig. 3, represent the width of the thwart, A M that of

the rower. Let A M = 2 x, so that the man's centre of gravity is over G, where G A = 1, A M = x.

Then the man's weight is proportional to the cube of x, and may be represented by mx^3. (The m will not trouble us.) And the moment y of the man's weight around the centre line of the boat's length is

$$= mx^3 \times \text{G B}$$

or $$y = mx^3 (1-x). \quad \text{Since A B} = 1 \text{ ft.}$$

Hence, following first rule given in the last lesson but one.

$$\frac{dy}{dx} = 3mx(1-x) - mx^3.$$

This represents the rate at which y increases as we increase x. When y is as great as possible, there is no longer any increase, therefore we must equate the above expression to zero, giving

$$3mx(1-x) = mx^3,$$

or $$3(1-x) = 1$$

$$3x = 2$$

or $$2x = \frac{4}{3}$$

This must be the amount of thwart occupied by the oarsman if his weight is to most effective. Since a man occupying a width of 1 ft. of thwart would weigh 6 stone, our oarsman should weigh

$$6 \times \left(\frac{4}{3}\right)^3$$

or $$\frac{128}{9} \text{lbs.}$$

i.e. 14 st. $3\frac{1}{9}$ lb.

PROBLEM II.—*A person is in a boat B (Fig. 4) three miles from the nearest point A, of a straight shore line, C D. He wishes to reach E, a point 5 miles from A, as quickly as possible. He can walk 5 miles an hour, but only row 4 miles an hour. Where must he land?*

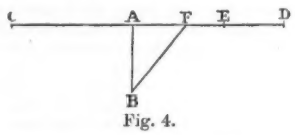


Fig. 4.

Suppose F is the point where he should land, and call A F, x. Then B A is perpendicular to C D.

And $$\text{B F} = \sqrt{\text{B A}^2 + x^2} = \sqrt{9 + x^2}.$$

Hence time taken in traversing B F is $\frac{\sqrt{9+x^2}}{4}$.

Again $$\text{F E} = 5 - x,$$

and time taken in traversing F E is $\frac{5-x}{5}$.

Thus if y = total time occupied in reaching E, we have

$$5 = \frac{\sqrt{9+x^2}}{4} + \frac{5-x}{5}.$$

Now following the two rules, we get readily,

$$\frac{dy}{dx} = \frac{x}{4\sqrt{9+x^2}} - \frac{1}{5}.$$

This expresses the rate at which the time increases as F is moved away from A. One can see that when x is very small the value of $\frac{dy}{dx}$ is negative, since a negative increase is decrease. This shows that our man will get to F more quickly by landing to the right of A (close by) than actually at A. And as long as $\frac{dy}{dx}$ continues negative this shortening continues. But as x increases, we reach at last a value for which $\frac{dy}{dx}$ ceases to be negative and becomes positive, passing through the value *nought*. When x has that value, the shortening has reached its utmost; so that to obtain the maximum we require, we have only to solve the equation,

$$\frac{x}{4\sqrt{9+x^2}} - \frac{1}{5} = 0,$$

or, $$5x = 4\sqrt{9+x^2},$$

i.e., $$25x^2 = 16(9+x^2)$$

$$= 144 + 16x^2.$$

This gives $$9x^2 = 144$$

$$3x = 12$$

$$x = 4.$$

So that our traveller must land four miles from A or one mile from F.

We see that whether for a maximum or minimum we must equate $\frac{dy}{dx}$ to zero. The question itself will show whether a maximum or minimum exists for the deduced value of x.

One more example will close the present lesson.

PROBLEM III.—*A sphere has a radius* r. *What is the greatest right cone which can be inscribed in the sphere?*

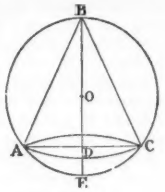


Fig. 5.

Let B D (Fig. 5), the height of the cone A B C, be x. Then D C, the radius of the base, is a mean proportional between B D and D E. That is $$\text{D C} = \sqrt{x(2r-x)}.$$

Hence the area of the base

$$= \pi x (2r-x),$$

and the content of the cone

$$= \pi x (2r-x) \times \frac{x}{3} = \frac{\pi x^2}{3}(2r-x).$$

(I assume a knowledge on the reader's part of the relations between the content and surface of cones, cylinders, spheres, and so on.)

Now put y for content of cone; that is, put

$$y = \frac{\pi x^2}{3}(2r-x),$$

and find the differential coefficient of y according to the first rule. We can write it down at once, thus,

$$\frac{dy}{dx} = \frac{2\pi x}{3}(2r-x) - \frac{\pi x^2}{3}$$

(the reader will at once see that the two portions of this value are obtained by Rule I., in last lesson but one.)

Now so long as by increasing x, y increases, we have not a maximum cone. Hence, since the differential coefficient expresses the rate of increase, we must have $\frac{dy}{dx} = 0$,

or $$\frac{2\pi x}{3}(2r-x) - \frac{\pi x^2}{3} = 0,$$

that is $$2x(2r-x) = x^2,$$

or $$4rx = 3x^2. \qquad \text{(i.)}$$

This gives $x = \frac{4r}{3}$, and, therefore, D must not be where it is shown in Fig. 5, but D E must be equal to twice O D. The reader will notice that (i.) is also satisfied if $x = 0$. We see that when $x = 0$, the volume of the cone is also nought. This is a minimum not a maximum value. It is clearly quite as necessary that the differential coefficient should vanish to give a minimum as to give a maximum. In all cases like the present, and indeed in nearly all the most useful simple applications of the calculus, the conditions of the problem itself show us when we have a maximum or a minimum. There *are* rules for analytically determining this; but I shall not trouble the reader with them. He sees in this case that the content of the cone starts from 0 when the height is 0, to 0 again when the height is $2r$; hence at some part of the passage from 0 to 0 the cone must have a maximum value; and the above process shows him (what he could not readily find by any other) that the cone has its maximum value when D E = 2 O D.

We regret that a very easy problem was given at p. 172 instead of this:—

To integrate $$d\theta = \left(\frac{4v^2 \times 3}{v^2+1}\right)^{\frac{1}{2}} dv$$

We regret that the omission escaped our notice in proof (or the index may have broken off in printing). The problem as actually given was correctly solved by J. R. C., An Engineer's Son, Kit, Menelaus, Arbuthnot, and others. X. Y. Z. solves correctly, another problem yet, having written $4v^3$ in numerator. The problem which should have been given (as above) is by no means so easy.

OUR WHIST COLUMN.—"Five of Clubs" considers that during the holiday season, Whist on alternate weeks, will satisfy our readers.

Our Chess Column.

GAMES BY CORRESPONDENCE.

IN the following game by correspondence the notes were taken by both players independently of each other, as the game progressed. We give both sets of notes.

TWO KNIGHTS' DEFENCE.

White. Chief Editor.	Black. Chess Editor.	White. Chief Editor.	Black. Chess Editor.
1. P to K4	P to K4	36. Kt takes R (*m*)	Ktakes Kt (13)
2. Kt to KB3	Kt to QB3	37. QR to K Bsq (14)	Kt to R4
3. B to B4	Kt to B3	38. Kt to K4	Q to Q5
4. Kt to Kt5	P to Q4	39. Kt takes Kt	Kt takes Kt
5. P takes P	Kt to QR4	40. K to R2 (*n*)	K to R2
6. B to Kt5 (ch)	P to B3	41. R to Ksq	Q to B3
7. P takes P	P takes P	42. K to Kt sq	R takes P
8. B to K2	P to KR3	43. Q takes RP (ch)	K to R3
9. Kt to KB3	P to K5	44. Q to B2 (*o*)	Q to Q3
10. Kt to K5	Q to B2 (1)	45. R to K6 ch (*p*)	15 Q takes R
11. P to Q4 (*a*) (2)	B to Q3	46. Q takes P (ch)	K to R2
12. P to KB4	P takes P en pas	47. R takes Kt	R takes R
13. Kt tks P on B3	B to KKt5	48. Q takes R	Q takes P
14. P to KR3 (3)	B to Kt6 (ch) 4	49. Q to B7 (ch)	K to Kt sq
15. K to Bsq (*b*)	B to B4	50. Q to Q8 (ch)	K to B2
16. B to K3	Castles KR	51. Q to Q7 (ch)	K to Kt sq
17. Kt to QB3	QR to Ksq (*c*)	52. Q to K8 (ch)	K to Kt2
18. Q to Q2 (*d*)	Kt to Kt2	53. Q to K5 (ch)	K to R2
19. B to Q3	Kt to Q3 (5)	54. P to KR5 (*q*)	Q to Kt8 (ch)
20. B to KB4 (*e*) (6)	B takes QB (7)	55. K to B2	Q to Q6 (*r*) (16)
21. Q takes B	Kt to R4	56. Q to K7 (ch)	K to Kt sq
22. Q to KR2nd (*f*)	B takes B (ch)	57. Q to K8 (ch)	K to R2
23. P takes B	Q to Kt3 (8)	58. Q to K5	Q to Qsq (*s*)
24. P to KKt4 (*g*)	Kt to B3	59. K to B3	K to R3
25. Q to Q2	Kt to R2 (9)	60. K to K4	Q to Q8 (*t*)
26. P to KR4 (*h*)	P to KB4	61. K to KB4	Q to Q7 (ch) (*u*)
27. P to KKt5	P to B5	62. K to KB5	Q to Q6 (ch)
28. P takes P (*i*)	Kt to B4 (10)	63. K to K6	Q to Kt6 (ch)
29. P takes P	Kt to Kt6 (ch)	64. K to KB6	Q to K Ktsq (17)
30. K to Kt sq (*j*)	R to B2 (11)	65. Q to K3 (ch)	K to R2
31. R to KR2	R takes P	66. Q to K4 (ch)	K to Rsq
32. R to KKt2	R to K6 (*k*)	67. Q to K7	Q to Kt8
33. Q to KB2	Kt to B3	68. Q to K8 (ch)	K to R7
34. Kt to KKt5	Q takes QP (12)	69. Q to Kt6 (ch)	resigns.
35. Kt to K6 (*l*)	Q to K4		

NOTES BY CHESS EDITOR.

(1) Q to B2 deserves a slight preference to Q to Q5, the usual continuation.

(2) 11. P to KB4 followed by 12. P to Q4 is given as the proper reply, or if Black replied with 11. P takes P *en pass.*, then 12. Kt takes P, B to Q3. 13. Castles; but the move in the text is by no means to be considered as bad.

(3) Bringing about a difficult game. White might have defended by Kt to Q2.

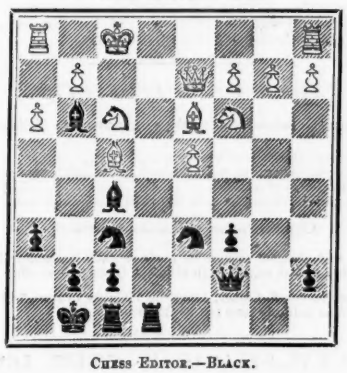
(4) 14. B takes Kt was stronger if White then retook with the B, B to Kt6 (ch), and Castles QR.

(5) 19. B takes B would have improved Black's attack, followed up by Kt to Q3 should White retake with Queen.

(6) This reply somewhat frustrates Black's intentions; the position is very interesting. We give a diagram of the

POSITION AFTER WHITE'S 20TH MOVE.

CHIEF EDITOR.—WHITE.



CHESS EDITOR.—BLACK.

(7) The position is now pregnant with interesting combinations Black might have followed a more advantageous line of play, which ought to have given him a winning superiority; but we can do no more than give some of the leading lines of play, as, after hours of labour, we found the variations too many for us to survey in our limited space :—

20.	B takes B (ch)			
21.	P takes B			
	Kt to R4			
22.	B takes Kt			
	Q takes B			
23.	Kt to K4		or Kt to K2	
	Q to Kt sq (Threatening P to B4)		R to B3	
24.	K to Kt sq	or R to Kt sq	K to Kt sq	or Kt to K5
	B to B4	P to KB4	KR to K sq	P to B3
25.	Q to QB2	Kt to B3	Kt takes B	Kt to QB4
	B to K6 (ch)	B to K6	Kt takes Kt	Q to K2
26.	Kt to B2	Q to QB2	R to R2	R to B sq
	Kt to Kt6	Kt to Kt (ch)	R to K7	B to R4
27.	R to R2	K to B2	Q to B sq	R to B2
	B takes Kt (ch) (Winning the Queen.)	B to K6 (ch) and wins.	KR to K6 (threatening R takes Kt and Q takes P ch.)	R takes Kt and wins.

but even though White had a more satisfactory reply than given in our analysis, Black ought to have obtained sufficient superiority to win.

(8) With the intention of taking KtP if the Queen took the Knight, but P to B4, with the intention of advancing it to B5, would have been better.

(9) Preparing for an advance of Pawns, with a preconceived idea.

(10) Having on his 20th move missed his catch, Black aims at obtaining an attack at some considerable risk to himself.

(11) Bringing the Rook to bear on the important Knight's file.

(12) Again the position is full of interest, and somewhat in Black's favour, 30. Q to B2, would have been a good move, as it threatens Kt to Kt5, *i.e.*,

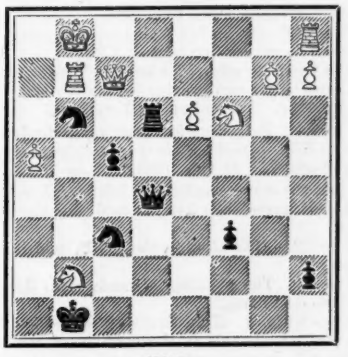
30. Q to B2 31. Kt to R3 / Kt B3 to R4 32. R to Ksq / R takes R (ch) 33. Q takes R / P to B6
34. Q to K8 (ch) / K to R2 35. Kt to Kt5 (ch) / R takes Kt 36. P takes R / P takes R

with some advantage. The move in the text also gave Black some considerable chance, as will be seen presently.

(13) Black gave up the exchange with the intention of now playing 36. Kt to Kt5, and if the White Queen moved to Q2, Black would win by Q to Q5, as he threatened a double discovered check with R to K8; but in reply to 36. Kt to Kt5, White had an ingenious defence in 37. P to Q4, if now Q takes P. 38. Kt to B5 wins for White; but taking the same line of play, we find that Black would, if not actually win, at least have the option of a draw by best play on White's side. We give a diagram of this interesting position, which will well repay the trouble of study.

POSITION AFTER WHITE'S 36TH MOVE.

WHITE.



BLACK.

XUM

Instead of 36. K takes Kt, Black ought to have proceeded as follows:—

36.	Kt to Kt5			
	P to Q4			
37.	Q to B3			
	Q to Q2	or Kt to R5 (best)		
38.	Q takes RP	Q takes QP	if Q takes RP	
	R to R2 (best)	R to Qsq	Kt takes Kt	
39.	Kt to K7 (ch)	R to K8 (ch)	P takes Kt	Kt takes Q
	Q takes Kt	R takes R	wins	Kt to B5 (ch)
40.	R to Kt6 (ch)	Kt takes Q		and White wins.
41.	K to Bsq (best)	Kt takes Kt	if R takes Kt (B7)	
	Kt take R (ch)	Kt to Kt5 (ch)	Kt takes Kt	
42.	K to Ksq	K to Rsq	R to K4	
	R to K6 (ch)	P to B6	Q to B3	
	and wins.	and wins.	with a fair game.	

(14) A good move, which materially affects Black's position.

(15) An ingenious device by which White simplifies matters.

(16) The ending is also of some interest. White tries hard to win; the move in text bids fair to draw. Q to B7 (ch) K to K3 would not have been good, as Black cannot allow the White King to cross over to the Queen side.

(17) Black held out as long as possible, but White played with very good judgment in bringing his King forward, and now he wins by force.

NOTES BY CHIEF EDITOR.

(*a*) P to Q4. "Gossip" corrects Wormald for giving this move intead of P to KB4, but the reply given by "Gossip" BQ3 12. PKB4 / Castles applies equally to both lines of play. If I had referred, however, to Cook's synopsis (3rd edition), I should probably have played 11. P to KB4, as he quotes Mr. Wayte's remark on the position attained in the above game after Black's thirteenth move, that Black has the advantage. Nevertheless the advantage is, I think, more apparent than real.

(*b*) 15. K to Bsq. The only move, of course. After this White will have a cramped position for a long time; yet he seems to have ample resources for defence. Black can hardly pursue his attack effectively without bringing round his Queen's Knight, and to do this he must cross the diagonal along which Black's Queen supports the advanced Bishop. Then will be the moment for White to free himself.

(*c*) 17. QR to Ksq. Showing how the attack is to be pushed. If merely aiming at the general development of his forces Black would probably have played his KR to Ksq, but to push the attack on White King, the command of the KB file is important.

(*d*) 18. Q to Q2. Threatening a counter-attack, should a suitable moment come. B takes RP, Q takes RP. Black will have to guard against any developments by which, after this, Q to KKt5 (ch) would win back the piece. Herein lies an element of safety for White.

(*e*) 20. B to KB4. This removes the obnoxious ecclesiastic from his threatening position.

(*f*) 22. Q to QR2. If Q to KR4, B takes B(ch) / P takes B, Kt to KB4, with fatal effect.

(*g*) 24. P to KKt4. At once protecting the QKtP and driving Knight back.

(*h*) 26. P to KR4. It is evident Black means to bring his KR into effective action, but by advance of KKtP his purpose may be foiled. For this advance, then, I prepare.

(*i*) 28. P takes P. Black is playing a bold game. This Pawn is clearly advanced to support his QKt at KKt 6. Yet, I think, I can safely take the Pawn he offers, for he will have to provide for his King's Rook, and then I can provide for mine.

(*j*) 30. K to Ktsq. The only move for safety.

(*k*) 32. R to K6. Defending his Pawn attackingly.

(*l*) 35. Kt to K6. Attacking his Queen defensively.

(*m*) 36. Kt takes R. If this (followed by P to Q4 should he reply by Kt to Kt5) is not a sufficient defence, there is none on the board. So I need waste little time in analysing the defence. It is a case of *must*.

(*n*) 40. K to R2. Threatening the KBP, which Black's reply effectually guards.

(*o*) 44. Q to B2. The situation abounds with dangers, and Her Majesty is wanted at home.

(*p*) 45. R to K6(ch.) Here is a way of escape from my uncomfortable position, though at the sacrifice of the exchange (for my QR pawn will be captured). I shall remain with one pawn ahead and a fair chance of winning, whereas at present there is a risk of mate in my hampered corner, and it is almost certain that if mate is avoided (as with care it may be) there will be a draw by "perpetual move." If I move R to R2 the reply, Q to KKt3 compels Rook to return. If I move K to R2, Q to KB3 compels King to return. If he play R to Q8, and afterwards Q to Q5, my rooks and Queen being where they are, how can I escape either mate or loss of my Queen? If the chance of escape were likely to remain open for another move I would push my QR Pawn (to save it after exchanges). But in these cases "if you will not when you may" (the proverb is something musty), so I take at once the chance for safety.

(*q*) 54. P to KR5. This, of course, is what I have been playing for the last five moves.

(*r*) 55. Q to Q6. If Black keeps to this sort of play, the game is, I fear, drawn. I can get my Queen to KB6 with a check, and then advance KRP; but there will be no escape from perpetual check.

(*s*) 58. Q to Qsq. Still I see no way to win.

(*t*) 60. Q to Q8. Of what wickedness is Mephisto capable! I could now play Q to KR8 (ch), and then advance KRP, both pawns being still guarded by Queen, *only* to this he would respond Q to K7 (ch), *winning at once!* Note, however, that apart from this, the play of Q to KR8 would be bad, for in that position she can never protect King from repeated checks, and the game would be drawn. It is drawn, I believe, any way.

(*u*) 61. Q to Q7 (ch). Demoralised, I imagine, by the failure of his evil design at move 60, Mephisto gives me a chance. I confidently cross my Queen's guard of KRP. He dare not take it, and once round that corner I can win.

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